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Observing Characteristics of Successful Interdisciplinary Design Courses Involving Engineering,
Art, Marketing, Psychology and Occupational Therapy

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MEMS 500 Independent Study

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Abstract

Collaboration among disciplines has been popular in education because of its flexibility in expanding scopes of knowledge and versatile approaches. In an interdisciplinary course during September - December 2017 at Washington University in St. Louis, students and professors across five different disciplines worked in collaboration to design a special sportswear for people in wheelchairs with spinal cord injuries. A qualitative research was conducted to investigate how participants' educational background influences the design process in such an interdisciplinary course setting through methodologies involving observations, documents, interviews and audio-visual materials of the course participants. This report is a documentation of the research. Findings of this research prove the effectiveness of such an interdisciplinary collaboration. It is recommended to optimize the recruitment process and results of students and faculty members from different disciplines, such as involving sufficient fashion design and engineering students, and reforming the syllabus in an effort to achieve more desirable course expectations. It is hoped that this research may foster more interests in interdisciplinary collaboration among Art and the STEM fields to further break down barriers among these disciplines.

Keywords: art, collaboration, engineering, fashion design, human-centered design, interdisciplinary, interdisciplinarity, interdisciplinary collaboration, wearable technology, special sportswear, STEM education

Observing Characteristics of Successful Interdisciplinary Design Courses Involving Engineering,
Art, Marketing, Psychology and Occupational Therapy

Interdisciplinary collaboration can be one of the most inspiring and rewarding pursuits to generate knowledge, not only in depth, but also in breadth. As continuous efforts go into expanding possibilities of interdisciplinary collaborations, there is an increasing need to further examine the performance of joining different combinations of disciplines in higher education. Such a realization motivates this observational research study, which aims to investigate how people from different disciplines interact through an Art course called Fashion Collaboration offered at Washington University in St. Louis. This research study is a qualitative one involving observations, documents, interviews and audio-visual materials with a small sample scale of 11 participants who enrolled in the Fashion Collaboration course, including 3 professors and 8 students. These participants are two undergraduate students led by Dr. Mary Ruppert-Stroescu from the Sam Fox School of Design & Visual Arts, six master's students in Occupational Therapy led by Dr. Christine Berg from the School of Medicine, and Dr. Mark J. Jakiela from the School of Engineering. Dr. Mark J. Jakiela is also the faculty sponsor of this research. As the principle investigator for this research, I am also involved in the Art 423 course as an engineering student to provide technical support to the project. The duration of the research was from August 28th to December 6th in 2017.

This report will provide details for the research study. I will first go over a literature review of practicing interdisciplinarity in an academic setting, and then define the aim of the study. In the Methods section, I will explain the approaches and methodologies used for conducting this qualitative research. Further, I will provide a summary of my analysis, and give recommendations to future researchers who might be interested in doing similar interdisciplinary

studies. In the Appendix, I will also offer a summary of the semester-long design project, which briefly illustrates the design process for the fashion garments produced. The reader may refer to the following list of primary sources I used in developing this research as well as writing this report.

- Creswell, J. W. (1998). *Qualitative inquiry and research design: choosing among five traditions*. Thousand Oaks, CA: Sage Publications.
- Frickel, S., Albert, M., & Prainsack, B. (2017). *Investigating interdisciplinary collaboration: theory and practice across disciplines*. New Brunswick, NJ: Rutgers University Press.
- Apostel, L., Berger, G., Briggs, A., & Michaud, G. (1972). *Interdisciplinarity: Problem of Teaching and Research in Universities*. André Pascal: OECD Publications.

Literature Review

What is interdisciplinarity? According to the definition proposed by Klein and Newell, it involves “a process of answering a question, solving a problem, or addressing a topic that is too broad or complex to be dealt with adequately by a single discipline or profession” (Julie Thompson Klein, William H. Newell, 1996). For decades, practices of interdisciplinarity have taken place in academies in the hope of promoting learning and producing new knowledge. It is proven to enhance the impacts of work produced, for instance, to increase public accountability and promote influence of the knowledge gained (Scott Frickel, Mathieu Albert, Barbara Prainsack, 2017) while engaging participants in a revisioned academic experience that provides a unique sense of discovery and exploration.

Given all the benefits of practicing interdisciplinarity, conflicts exist between the desirability of interdisciplinary collaboration and the difficulty of successfully joining disciplines. Such conflicts deal with the difficulty of producing interdisciplinary knowledge with one combination of disciplines over another that has fewer constraints in the disciplines themselves. To explain this further – there are traditional boundaries believed to exist among disciplines, especially between academic and artistic subjects. As a result, interdisciplinary collaborations usually form among closely related disciplines from arts and archeology to life sciences and medicine. Traditional academic disciplines, such as STEM (Science, Technology, Engineering and Math), have an extraordinarily hard time going beyond their neighboring fields.

Some may claim that Science is becoming ever more interdisciplinary, whereas in a research conducted by Porter and Rafols in 2009, this statement was proved to be anecdotal and partial. The authors illustrated several modified Science overlay maps (or Basemap of Science) which allowed for visualization of how distant traditional study domains are to each other. It was observed that Science domains tended to only overlap with its related fields in STEM, indicating difficulties in exploring complementarities and potential collaborations of Science with more distant disciplines. On the other hand, between 1975 and 2005, for six¹ research domains in Science, the practice of interdisciplinarity in citations occurred mainly between neighboring disciplines and only underwent a moderate increase of 5% on average. Clearly, feasibility of collaboration among Science and other disciplines awaits more investigation.

¹ The six selected subject categories are: Biotechnology & Applied Microbiology (Biotech), Engineering, Electrical & Electronic (EE), Mathematics (Math), Medicine – Research & Experimental (Medicine – R&E), Neurosciences (Neurosciences), and Physics – Atomic, Molecular & Chemical (Physics – AMC).

In efforts to promote interdisciplinarity in traditional STEM fields, one term STEAM (Science, Technology, Engineering, Art and Math) is becoming increasingly prominent in general education. Scholars and students in Art and STEM fields strive to promote collaboration from diverse approaches, forms and structures, including but not limited to traditional learning communities of students and of faculty, problem-focused research projects, shared facilities, databases, and instrumentation, enhanced disciplinary curricula to accommodate new developments in scholarship and research, training in collaborative modes and teamwork, etc. (Julie Thompson Klein, William H. Newell, 1996).

These collaborations have resulted in the emergence of many interdisciplinary offerings and programs at universities around the world. In the United States, people see the emergence of new STEAM collaborations every once in a while, and are fascinated by the idea of adding creativity to the standard STEM education, though also experiencing push-back from both STEM and Art proponents. We need scholars and students who are motivated and competent to bring forth solutions to problems in more diverse interdisciplinary collaborations.

Aim of Study

The aim of this study was to address the question: how does participants' educational background influence the design process of a fashion garment in an interdisciplinary course setting? In order to answer this question, I proposed the following objectives indicating key issues to be focused on while practicing qualitative research methodologies. Since the research was constrained to only a 15-week period, it was crucial to adhere to these objectives.

- To determine participants' motives and level of interests in an interdisciplinary collaboration like this one.

- To identify characteristics of the participants' approach to complete tasks at different phases of the project.
- To explore differences among people from a variety of disciplines, involving Art, Engineering, Marketing, Psychology and Occupational Therapy.
- To learn about participants' interdisciplinary experience.
- To identify challenges and provide recommendations to future interdisciplinary collaboration in developing wearable technology

Methods

Recruitment Strategy

Recruitment of this research took place in the fall 2017 semester during a regular class meeting of the ART423 course (Fashion Collaboration) at the Sam Fox School of Design and Visual Arts at Washington University. All participants of the course, including three professors and eight students, were invited to join the research. These faculty members and students were notified about this course opportunity either through their own departments (i.e. student advisors) or the course listing during summer 2017. An oral description of this research was presented to the course participants. A text version of this description is shown in Appendix A. Since the goal of this research aligns with that of the course – to interact people from different disciplines through fashion design – no additional materials or strategies were used during the recruitment process. All people invited agreed to join the research. For human subject protection purposes, access to research sites and individual permissions (consent letters) were requested and obtained. The WUSTL Institutional Review Board (IRB) agreed to oversee the research and exempted the study from a full review.

Data Collection Method

The four approaches to data collection in this study were observations, interviews, documents, and audio-visual materials. Observations were made during regular class meetings every Monday and Wednesday throughout the semester, excluding holidays. Observational protocols were used to log information learned during each class session. As shown in Table 1, this protocol recorded information on a class meeting on September 20th to gather interview questions for a customer interview. Such an observational protocol was repeatedly used throughout the research to record descriptions of activities and self-reflections – reflection notes, notes about the activity, and conclusions for further data analysis.

Table 1

Sample Observational Protocol

Length of Activity: 40 minutes	
Descriptive Notes	Reflective Notes
General: Customer interview preparation – to brainstorm and organize questions to ask during the first face-to-face interview with the potential customer (rugby players)	
The students are divided into two teams to come up with their own design in the future. Each team has three Occupational Students and one student who registered to the ART 423 course, either major in Marketing or Psychology. Since there's only one engineering student in the class, the engineering student will be on both teams to provide any technical support needed.	I wonder if the students that are not in OT major would have problem expressing ideas in discussion. – No.
See classroom layout and how students sit as two teams of four	I wonder if the setting is productive for discussion. – Would be better if it is a classic studio setting with studio tables and stool chairs rather than a conference room setting with a large table in the middle and chairs around.

Length of Activity: 40 minutes

Students utilized Google Docs to instantly share their results and updates	Notice who is the one taking notes, who comes up with more new ideas, who controls the pace of discussion, etc.? Also notice which word better describe the person's talking style, "reserved" or "aggressive"?
Each team had two mock interviews with Dr. Jakiela and Dr. Ruppert-Stroescu separately	I wonder if I should followed the same interviewee or stay with the same group for observations? – Followed the interviewee and noticed how students on each team carried out the questions differently. Because the lead interviewers come from different educational background, some emphasize on developing interview skills.
Greet the interviewee; sign the agreement; lead interviewer asks questions; one person takes notes	See if the interview is thorough in terms of getting answers for what the group wanted to know. - The interviewee tends to share less information with one team compared to another because of the questions covered and flow of conversation

Similarly, interview protocols were used to organize thoughts and to take notes during interviews. Three interviews were given to the three instructors of this course separately during the last week of the course. The interview protocol used can be found in Table 2. Audio recordings were also taken to ensure the comprehensiveness of data collected. This method was used to only gather feedback from the instructors in that each interview would last about 30 minutes, which could be too time consuming to be done on each student. The recordings were made and stored in my cell phone, and would be deleted upon submission of this report to the WUSTL Open Scholarship.

Table 2

Interview Protocol

Instructor's Experience for Fashion Collaboration Class

Time of Interview	
Date	
Place	
Interviewee	
Position of Interviewee	

Questions

1. What has been your role in this course?

2. What motivates you to join this course? How did you get involved in this course?

3. What were your expectations to your student(s)?

4. What are the challenges for being an instructor to this class?

5. *How is the course different from the one last year?

6. What will you change if you are going to be an instructor for this course next year?

(Thank individual for participating in this interview.)

Note: * indicates an optional question

As for students, surveys were distributed during the last class meeting of the semester to learn about their interdisciplinary collaboration experience. The survey used is attached in Appendix B. These surveys were printed on paper and would be destroyed with a paper shredder upon submission of this report to the WUSTL Open Scholarship.

Data Analysis Method

In the analytic phase of this study, the conventional content analysis (or inductive content analysis²) approach was used. A general review of all information collected was first prepared. This was done by reading through all the observational protocols, interview protocols and surveys, and going over the interview recordings to get an idea of the overall data. Then, written memos were done on the interview recordings and reflective notes were taken on the surveys for ease to sort out key points to include in conclusions. These memos and notes are attached in Appendix C. After these, all information was reduced into drafts of the Findings and Discussion section for this report. A template that was used to interconnect analysis to writing in this study is provided in Table 3.

Table 3

Template for Data Analysis Elements and Writing Objectives

Data Analysis Elements and Writing Objectives	
Data Analysis Element	Writing Objective
Create a template for analysis	Develop a visual of data analysis
Create headings in the manuscript for major themes	Create four or five major themes in the study in words of participants
Title the manuscript	Create a little in the words of the participants – to make report realistic, to catch attention of readers
Include quotes in the manuscript	Identify goof quotes that provide sound evidence for the themes, description, interpretation, and so forth
Phrase study in words of participants	Locate commonly used words or phrases and develop them into themes

² Inductive content analysis derives information directly from the raw data collected. It allows the researcher to directly gain information from the participants without preconceived theoretical perspectives having been imposed. The term is used in contrast to deductive content analysis (or directed content analysis). (Francesca Moretti, Liesbeth van Vliet, Jozien Bensing, Giuseppe Deledda, Mariangela Mazzi, Michela Rimondini, Christa Zimmermann, Ian Fletcher, 2010)

Data Analysis Elements and Writing Objectives

Create a comparison table	Compare categories of information
Show levels of abstraction in the analysis	Present a visual of the categories in the analysis
Discuss metaphors	Find text in which metaphors are presented and group into categories

Note: This table is taken partially from the Data Analysis and Representation section of the book Qualitative Inquiry and Research Design.

Findings and Discussion

Current Situation

1. Participants are able to make contributions that are consistent with their knowledge and skills in their home disciplines.

The Psychology and OT students are able to support the project from a client-centered focus while enhancing their professional abilities. Their skill sets are especially helpful when interacting with the customers who are all impaired people with special needs. One suggests that:

I am able to apply activity analysis, occupational interviewing, and clinical reasoning to assist in designing clothing for wheelchair users who play sports.

Another respondent in Marketing notices that his/her communication and analysis skills developed through previous learning are beneficial to understanding customer needs:

In my discipline, we have gained experience regarding surveys, marketing research and customer profiles. In this course I have contributed my knowledge of conducting and analyzing surveys, as well as my experience communicating with customers to assist my group.

As for Engineering, one of the design goals was to include a cooling mechanism in the garment, which requires understanding of thermodynamics, materials selection, manufacturing

techniques, etc. Through practicing the engineering design process, the Engineering student makes the product more functional.

2. Uniqueness of the Psychology student appears to be ambiguous in terms of specialized knowledge and skills.

The knowledge and skills of the Psychology student seem to overlap with that of an OT student. Both disciplines tend to advocate a human-centered mindset that strives to improve people's mental health. The distinction is similar to that between a psychologist and a therapist. In an interdisciplinary academic setting, the differences are subtle, and OT students appear to have a broader scope of knowledge. A primary reason for this is because the sample size of one Psychology student is too small, and the class level of that participant is sophomore, whereas all OT students are studying towards their master's degree.

3. Participants enjoy learning about other disciplines and collaborating.

The interdisciplinary environment creates a platform for people to share their knowledge while gaining additional expertise that is not common to acquire within their home disciplines. One respondent mentioned that once a person gets into the industry, he/she will need to be open to learning from other disciplines while sharing knowledge. It is also interesting to see what each discipline brings to the table while working towards the same project goal.

4. Students bring a broad range of competencies from their home disciplines, while their degree of contribution varies as the project proceeds through different phases.

Certain disciplines seek to magnify students' ability to effectively communicate with people of all kinds, such as Marketing and Occupational Therapy. Therefore, people in these majors are stronger communicators during the initial design of the garment, whether among the

designers or between the designers and the customers. Engineering majors tend to prove their significance at later stages of the project, when technical support is sought. Once the garment is fabricated, business majors become essential in estimating costs, marketing the product, etc.

5. Students often have different approaches to solving the same problem or to completing the same task.

The Psychology and OT students are client-focused and highly human-centered. The Marketing student is business-oriented. The engineering student is solution-oriented. Communications both within the group and with the customers showcase different mindsets that students don't typically encounter in their home disciplines.

6. There are not enough students in the class to form fully functional teams.

Progression of the design and fabrication of the garment as well as subsystems are highly restricted by the lack of fashion design and engineering students. Few people even know the basics for fashion design, such as to create different types of sketches, identify fabrics, sew pieces with a sewing machine, etc. As a result, the fashion design instructor spends a significant amount of time teaching fundamentals of fashion design as well as completing tasks that belong to fashion design students so that the project can proceed to the next phase. As for engineering, the development of a subsystem for a garment not only relates to mechanical engineering, but also a wide range of engineering topics, involving materials sciences, electrical engineering, biomedical engineering, etc. The design and manufacturing of such a subsystem can be seen as a separate project to be solved by a group of engineers and designers.

7. Motivations for the instructors seem to relate closely to professors' personal interests and requirements of the university system.

Looking through the interviews, I notice two primary motives for professors to join this interdisciplinary collaboration:

- The course needs support in the professor's field of expertise.
- The professor has strong interest in interdisciplinary collaboration of this kind.

In addition, the Fashion Collaboration course is a pilot course – offered only once in the last year – and worth continuing. The professors are willing to join or continue teaching this course.

Challenges to Overcome

8. Recruitment for the interdisciplinary course poses special challenges for various reasons.

As mentioned before, recruitment for the course happened during summer 2017 when students are on holidays. Many students are not aware of this opportunity. Moreover, a majority of fashion design students who fall under the desired class level are studying abroad in fall. At the same time, other class levels are offered highly competitive course options, such as Textiles and Fabrics. Moreover, only three engineering students initially expressed interest in this course, all of which were female. Incorporating the relatively low ratio of female to male students in engineering at the university (3:7), attracting engineering students to fashion collaboration is a big challenge.

9. Maintaining disciplinary identity consistent with home discipline is challenging.

The project requires a large amount of work done in the field of fashion design, but teams lack fashion design students. As a result, regardless of a student's educational background, he/she has to complete tasks that fall under the duties of a fashion design student. This is different from occasionally assisting teammates or working on assignments across disciplines on

purpose, such as to understand a topic from another angle. When the main contribution of a student is centered on another discipline, the objectives and expectations for that person to join the course may not be met. In other words, the balance between giving and receiving knowledge from disciplines is expected to be moderate. In the survey, two out of eight students reported not having their primary motivation in learning more about fashion design. In another response to whether one prefers practicing skills and applying knowledge in their home disciplines over gaining additional expertise, the respondent expressed a strong preference to still retain an identity within his/her home discipline even in an interdisciplinary setting. In other words, some students prefer practicing knowledge and expertise in their home discipline to feeling that the subjects they are studying are relevant to reality.

10. Given only 15 weeks for this interdisciplinary collaboration, there exists a conflict between keeping the complexity of the problem and requiring many disciplines throughout the design process.

Though it is undeniable that every student is able to contribute uniquely to the collaboration, students may still find their work replaceable by students from other disciplines. One example is that the knowledge and skills of a Psychology student are similar to those of an OT student when the problem is not complex or broad enough to justify the distinction between the two disciplines. Many procedures in the design process could use more in-depth analysis and discussion, but risks going beyond the allowed time frame to do so. In addition, these in-depth explorations may also require extra dedication to the project that goes beyond the students' availability and interests. Yet simply going through the process without going into details every time would restrict complexity of the product produced. For example, keeping complexity of the engineering subsystem design would require extra time and manpower, whereas a simpler design

could be achieved by students who do not have much knowledge in engineering. Another example is that the product we produced has a large potential to appear in the market, but due to the time and efforts required to complete all the initial processes to get desired results, the marketing student does not have enough time to make it happen.

11. Having different graders for different students restricts the progression of the project due to the interdisciplinary setup.

We appreciate having three prestigious professors to join the interdisciplinary course and having them bring in students in their home disciplines. It appears logical that each professor will grade his/her own student based on different expectations and standard rubrics in different disciplines. However, this made it hard for professors to distribute and collect assignments for all students. As a result, a common scenario was that students did not have all the work done by the deadline, thus pushing back progression of the project.

Conclusion

On the basis of my findings and discussions, I conclude that the interdisciplinary experience through the Fashion Collaboration course was a successful one. It allowed students to gain additional expertise and borrow new ideas from two or more disciplines while providing a platform for students to share their knowledge and skills learned in their home disciplines. The perspectives, theories, tools and techniques involved in the design process came from as many as five disciplines, which are Art, Engineering, Psychology, Marketing and Occupational Therapy. Though some knowledge and skills appeared to be overlapping, students demonstrated their unique mindsets and strengths at different phases of the project.

On the other hand, there is always space for improvement. The following recommendations are made for future courses that aim to develop special clothing for people in need through practicing interdisciplinarity.

- Advertisement for the course may focus on wearable technology rather than fashion design to attract students.
- The course objectives, structure and timeline may be tailored for different disciplines by offering separate syllabus to students. This will ensure a desirable interdisciplinary experience for each participant.
- Regular class meetings may be held at classrooms in a studio setup rather than a conference setup for ease in organizing discussions, presentations, and studio working.
- Engineering students may join the course after mid-term when the project reaches a later phase of the design process to provide technical support wherever in need, as is usually true in the industry.

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Footnotes

¹ The six selected subject categories are: Biotechnology & Applied Microbiology (Biotech), Engineering, Electrical & Electronic (EE), Mathematics (Math), Medicine – Research & Experimental (Medicine – R&E), Neurosciences (Neurosciences), and Physics – Atomic, Molecular & Chemical (Physics – AMC).

² Inductive content analysis derives information directly from the raw data collected. It allows the researcher to directly gain information from the participants without preconceived theoretical perspectives having been imposed. The term is used in contrast to deductive content analysis (or directed content analysis). (Francesca Moretti, Liesbeth van Vliet, Jozen Bensing, Giuseppe Deledda, Mariangela Mazzi, Michela Rimondini, Christa Zimmermann, Ian Fletcher, 2010)

Appendix A

Oral Description of the Research for Recruitment

I am currently doing an observational research study on this interdisciplinary design course we are taking. The official title is Observing Characteristics of Successful Interdisciplinary Design Courses Involving Engineering, Art, Marketing, Psychology and Occupational Therapy.

I would like to invite you to participate in my study as you play a key role in our design project because of the unique educational background you have. I would like to observe how you approach the project at different phases, hear your thoughts about the design process, and gather your suggestions on such collaboration project settings. Interviews and supplemental survey will be distributed at the end of the semester for these purposes. I will also write a report about my observations, documentation and conclusions based on your inputs throughout the semester. Your personal identifiers will be removed. The report will be published on the MEMS Open Scholarship.

Please read through the consent letter and let me know if you have any questions. If you would like to participate in this study, please sign on the second page of the consent letter and return it to me in the provided envelop. Thank you!

Appendix B

Project Summary

The purpose of this project is to design, fabricate and deliver an athletic wear to people in wheelchairs with spinal cord injury. Major end users of the garments are people with similar level of sensation and motor control of their upper body to a C6-C8 vertebrae injury. Injuries of these levels result in paralysis of the legs, trunk, and hands, with patients maintaining limited shoulder, arm and finger movements. In addition, some patients may have abnormal body temperature regulation and inability to respond to changes in the environment.

We worked on two project teams and successfully made two iterations of prototypes. We started with an extensive background research on current market, technology development, and ongoing efforts on clothing for people with disabilities. Then, we discovered customer needs through discussions in class and interviews with the local user community. Some of us had the fortune to attend a regular practice session with the St. Louis Spartan Wheelchair Rugby team, and talked to various players about their needs and preferences. Some met with other wheelchair people who hopes to do regular workout occasionally. After creating customer personas, we created technical sketches and mood boards, decided color ways, and made material selections, as shown in the following two figures.

Resilience

Design Problem:

Universally Friendly Athletic Wear: Create a prototype for individuals who use mobility devices that addresses their needs when competing in competitive sports.

Literature Review:

- Currently on the market: CHAIRMELOTTE, Nike Aeroreact, Nike Flyease, Cat and Jack for Target, Patti + Ricky, Runway of Dreams by Tommy Hilfiger, Zappos Adaptive
- Current Relevant Collaboration Project: Open Style Lab, Disrupt Aging Design Challenge
- Further steps towards outdoor clothing for people with disabilities to enjoy sports (Strickfaden, M., Yu, X., Tullio-Pow, S., 2016)
Determined in extreme sport clothing design that it is important to consider access, physical, and mobility needs
- Chan, A. P., et al. (2016). "The development of anti-heat stress clothing for construction workers in hot and humid weather." *Ergonomics* 59(4): 479-495.
Considering thermal-moisture properties of clothing for individuals in extreme conditions
- Pires, A. and R. Miguel (2012). "Design of therapeutic clothing for sensory stimulation of children with psychomotor delay." *Work* 41 Suppl 1: 4739-4745.
Important for clothing to be both functional and comfortable, considering the therapeutic use of additions to the basic clothing

Customer Persona and Design Criteria:

- Competitive Wheelchair Athlete
- Resilient, Self-aware, and Self-determined
- 18-45 years old, male and female, based in the U.S.A

Value Added Ideas:

- Temperature regulation
- Reinforced fabric for durability and safety
- Ease in donning and doffing

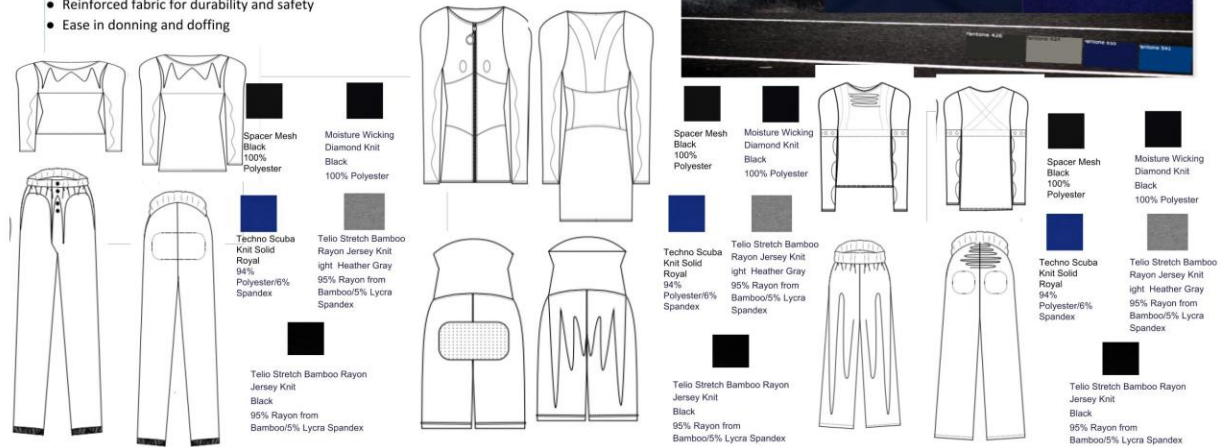


Figure 1 Presentation Board for Athletic Wear Design for Wheelchair Rugby Players Produced by Team "Resilience"

Fitness Apparel for Individuals with Disabilities: Designing for an Unmet Need

Design Problem

Provide individuals with disabilities fitness apparel, for any workout activity, that is easy to don/doff and remains in place throughout the course of a workout. Clothing will maintain aesthetic appeal and provide desired coverage.

Literature Review

- According to the World Health Organization, 15% of people globally live with a disability
- There is very little research on disability and clothing selection
- 50-100% of individuals with disabilities have difficulty finding clothing that meets their sizing and fit needs
- Individuals with disabilities may experience public self-consciousness that affects their self-concept and, in turn, their self-esteem
- Many women with disabilities have problems with style and fit of fashionable clothes, dressing and undressing, caring for their clothes, and buying clothes

Customer Persona and Design Criteria

Our user is a man in his 30's who likes to exercise at the gym. He tries to exercise three times a week and has exercised his whole life. He experienced a spinal cord injury a year ago but continues to exercise to maintain his health and to stay social at the gym. He uses a wheelchair for mobility. He gets ready in the morning independently and puts his workout clothing on first thing in the morning. He prefers that his workout clothing be comfortable and functional but stylish. He wants clothing that dons and doffs easily, stays in place, allows full range of motion, and is resistant to breakdown.

Value Added Components

- Thumb holes: to ensure that the clothing stays in place
- Stretchy material along sides of arms and body: for comfort and easier donning/doffing
- Extra padding in seat of pants: to prevent pressure sores
- Magnet closures: for easier donning/doffing
- Side pockets: with accessible openings
- Holes on sides of pants: for easier donning/doffing
- Temperature sensors: tracks temperature and monitors heart rate and how intense your workouts are
- Thermo cooling finish: this finish releases active ingredients to the skin so that it cools off. The effect can be compared to a soothing balm, but in this case, the ingredients are activated when they're needed

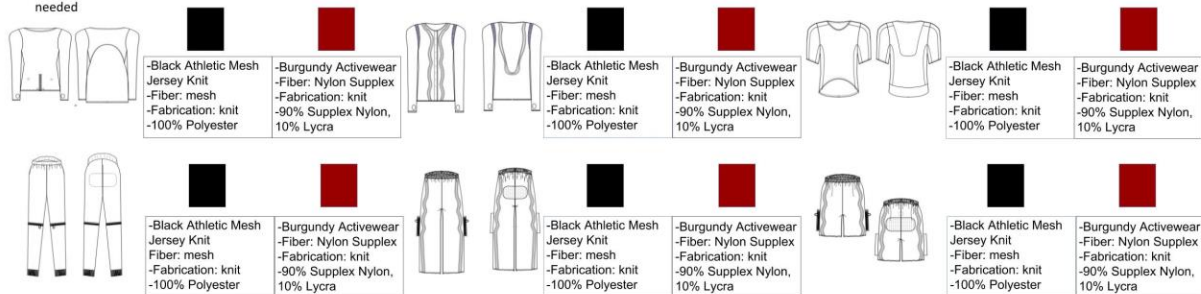


Figure 2 Presentation Board for Athletic Wear Design for Wheelchair Workout People Produced by Team "Elements"

In order to test our designs, we invited two representative models to our presentations and fitting sessions based on their special needs. One of them plays rigorous sports on the rugby team, and one occasionally does upper body workout. The distinction between the two user groups behind is the intensity of sports, which leads to different requirements for temperature regulation, complexity of garment subsystems, easiness to don and doff, etc. The following figure shows the adapted manual wheelchair for rugby players.

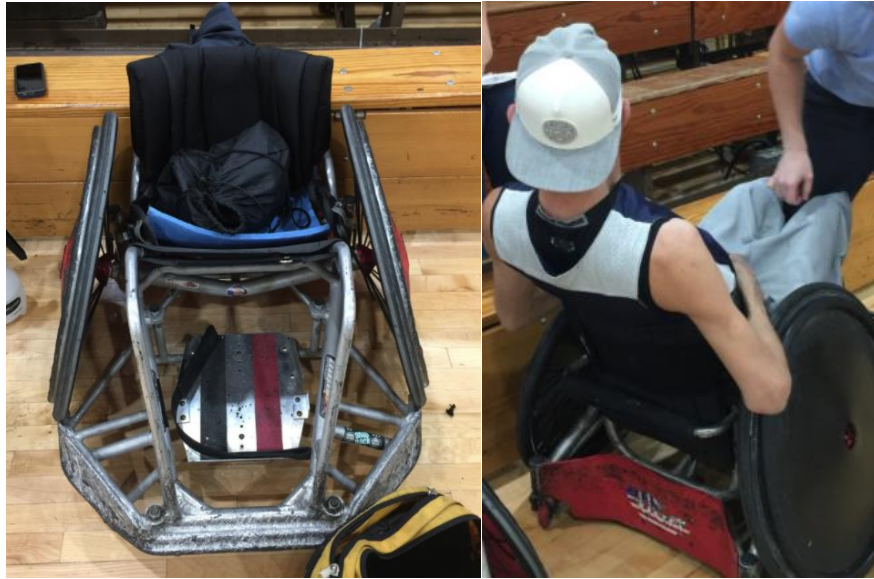


Figure 3 Specialized Wheelchair for Playing Rugby

In the design for wheelchair rugby players, an additional cooling system is integrated into the garment to provide moderate heat extraction from the user's upper body. Due to safety concerns, this cooling system adopts only the basic heat transfer principle between solids of different temperature in contact. No additional subsystems, such as compressors, evaporators, etc. are attached to the garment or wheelchair in any form, in order to limit unintended consequences, involving possible wheelchair crashes during the game, attachments poking skin, etc. The idea behind is to use a thin metal that is treated to form a designed shape and attach it to an insulated cool pack inside the garment. The metal piece will conform to the user's body shape and be directly in contact with the user. We were able to illustrate this idea to our user with a copper wire and a DIY ice pack, as shown in figure 5.



Figure 4 Copper Wire and DIY Ice Pack

In the design of the other team for customers who does work out regularly, no additional mechanisms are used. The team organized a fitting session with the potential user and helped the customer put on prototypes of the outfit, top and bottom, as shown in Figure 6 and Figure 7.



Figure 5 Prototype of the Garment (Top) by Team “Elements”



Figure 6 Prototype of the Garment (Bottom) by Team “Elements”

In conclusion, through this project, we created two sportswear that address aesthetic, comfort and functionality for people in wheelchair with special needs. The next phase is in regards to the cooling system design and finalizing materials and fabrication process for further market review. The newly designed cooling system will supply abundant continuous sensation of cooling while ensuring the user’s safety, comforts and aesthetic in the garment. We hope this

project be continued on for further development in the wearable technology industry and restoring a sense of normalcy to those who require these redesigned garments.

Tables

Table 1

Sample Observational Protocol

Length of Activity: 40 minutes	
Descriptive Notes	Reflective Notes
General: Customer interview preparation – to brainstorm and organize questions to ask during the first face-to-face interview with the potential customer (rugby players)	
The students are divided into two teams to come up with their own design in the future. Each team has three Occupational Students and one student who registered to the ART 423 course, either major in Marketing or Psychology. Since there's only one engineering student in the class, the engineering student will be on both teams to provide any technical support needed.	I wonder if the students that are not in OT major would have problem expressing ideas in discussion. – No.
See classroom layout and how students sit as two teams of four	I wonder if the setting is productive for discussion. – Would be better if it is a classic studio setting with studio tables and stool chairs rather than a conference room setting with a large table in the middle and chairs around.
Students utilized Google Docs to instantly share their results and updates	Notice who is the one taking notes, who comes up with more new ideas, who controls the pace of discussion, etc.? Also notice which word better describe the person's talking style, "reserved" or "aggressive"?
Each team had two mock interviews with Dr. Jakiela and Dr. Ruppert-Stroescu separately	I wonder if I should followed the same interviewee or stay with the same group for observations? – Followed the interviewee and noticed how students on each team carried out the questions differently (mainly because the lead interviewers come from different educational background)
Greet the interviewee; sign the agreement; lead interviewer asks questions; one person takes notes	See if the interview is thorough in terms of getting answers for what the group wanted to know. Does the interviewee shared less information with one team compared to another? Why?

Table 2

Interview Protocol

Instructor's Experience for Fashion Collaboration Class	
Time of Interview	
Date	
Place	
Interviewee	
Position of Interviewee	

Questions

7. What has been your role in this course?

8. What motivates you to join this course? How did you get involved in this course?

9. What were your expectations to your student(s)?

10. What are the challenges for being an instructor to this class?

11. *How is the course different from the one last year?

12. What will you change if you are going to be an instructor for this course next year?

(Thank individual for participating in this interview.)

Note: * indicates an optional question

Table 3

Template for Data Analysis Elements and Writing Objectives

Data Analysis Elements and Writing Objectives	
Data Analysis Element	Writing Objective
Create a template for analysis	Develop a visual of data analysis
Create headings in the manuscript for major themes	Create four or five major themes in the study in words of participants
Title the manuscript	Create a title in the words of the participants – to make report realistic, to catch attention of readers
Include quotes in the manuscript	Identify good quotes that provide sound evidence for the themes, description, interpretation, and so forth
Phrase study in words of participants	Locate commonly used words or phrases and develop them into themes
Create a comparison table	Compare categories of information
Show levels of abstraction in the analysis	Present a visual of the categories in the analysis
Discuss metaphors	Find text in which metaphors are presented and group into categories

Note: This table is taken partially from the Data Analysis and Representation section of the book *Qualitative Inquiry and Research Design*.

Figures

Resilience

Design Problem:

Universally Friendly Athletic Wear: Create a prototype for individuals who use mobility devices that addresses their needs when competing in competitive sports.

Literature Review:

- Currently on the market: CHAIRMELLOTTE, Nike AeroReact, Nike Flyease, Cat and Jack for Target, Patti + Ricky, Runway of Dreams by Tommy Hilfiker, Zappos Adaptive
 - Current Relevant Collaboration Project: Open Style Lab, Disrupt Aging Design Challenge
 - Further steps towards outdoor clothing for people with disabilities to enjoy sports (Strickfaden, M., Yu, X., Tullio-Pow, S., 2016)
- Determined in extreme sport clothing design that it is important to consider access, physical, and mobility needs
- Chan, A. P., et al. (2016). "The development of anti-heat stress clothing for construction workers in hot and humid weather." *Ergonomics* 59(4): 479-495.
- Considering thermal-moisture properties of clothing for individuals in extreme conditions
- Pires, A. and R. Miguel (2012). "Design of therapeutic clothing for sensory stimulation of children with psychomotor delay." *Work* 41 Suppl 1: 4739-4745.
- Important for clothing to be both functional and comfortable, considering the therapeutic use of additions to the basic clothing

Customer Persona and Design Criteria:

- Competitive Wheelchair Athlete
- Resilient, Self-aware, and Self-determined
- 18-45 years old, male and female, based in the U.S.A

Value Added Ideas:

- Temperature regulation
- Reinforced fabric for durability and safety
- Ease in donning and doffing



Figure 1 Presentation Board for Athletic Wear Design for Wheelchair Rugby Players Produced by Team “Resilience”

Fitness Apparel for Individuals with Disabilities: Designing for an Unmet Need

Design Problem

Provide individuals with disabilities fitness apparel, for any workout activity, that is easy to don/doff and remains in place throughout the course of a workout. Clothing will maintain aesthetic appeal and provide desired coverage.

Literature Review

- According to the World Health Organization, 15% of people globally live with a disability
- There is very little research on disability and clothing selection
- 50-100% of individuals with disabilities have difficulty finding clothing that meets their sizing and fit needs
- Individuals with disabilities may experience public self-consciousness that affects their self-concept and, in turn, their self-esteem
- Many women with disabilities have problems with style and fit of fashionable clothes, dressing and undressing, caring for their clothes, and buying clothes

Customer Persona and Design Criteria

Our user is a man in his 30's who likes to exercise at the gym. He tries to exercise three times a week and has exercised his whole life. He experienced a spinal cord injury a year ago but continues to exercise to maintain his health and to stay social at the gym. He uses a wheelchair for mobility. He gets ready in the morning independently and puts his workout clothing on first thing in the morning. He prefers that his workout clothing be comfortable and functional but stylish. He wants clothing that dons and doffs easily, stays in place, allows full range of motion, and is resistant to breakdown.

Value Added Components

- Thumb holes: to ensure that the clothing stays in place
- Stretchy material along sides of arms and body: for comfort and easier donning/doffing
- Extra padding in seat of pants: to prevent pressure sores
- Magnet closures: for easier donning/doffing
- Side pockets: with accessible openings
- Holes on sides of pants: for easier donning/doffing
- Temperature sensors: tracks temperature and monitors heart rate and how intense your workouts are
- Thermo cooling finish: this finish releases active ingredients to the skin so that it cools off. The effect can be compared to a soothing balm, but in this case, the ingredients are activated when they're needed

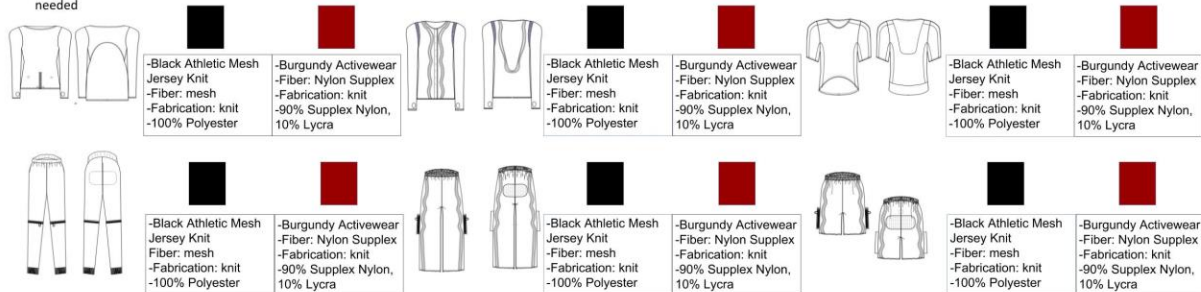


Figure 2 Presentation Board for Athletic Wear Design for Wheelchair Workout People Produced by Team "Elements"

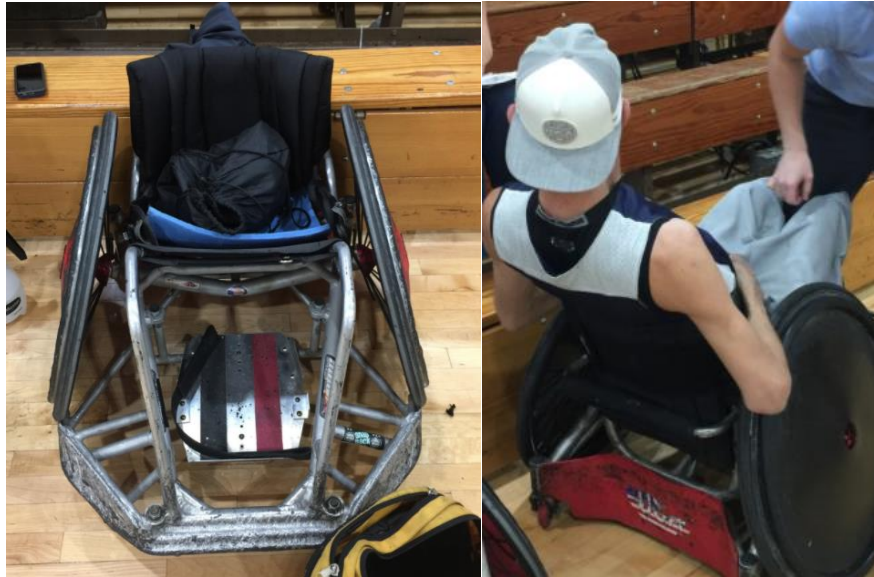


Figure 3 Specialized Wheelchair for Playing Rugby



Figure 4 Copper Wire and DIY Ice Pack



Figure 5 Prototype of the Garment (Top) by Team “Elements”



Figure 6 Prototype of the Garment (Bottom) by Team “Elements”